NEW MOORED SENSORS FOR MEASURING AIR-SEA GAS EXCHANGE

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1. INTRODUCTION

There is a need within the air-sea gas exchange community to develop *in-situ* dissolved gas sensors capable of making reliable hourly measurements on remote moorings or floating-platforms (recoverable and non-recoverable) over time scales of months to years to enable calculation of air-sea gas exchange rates and fluxes. Measurements must have sufficient sensitivity to resolve changes in dissolved gas saturation levels associated with the passage of storms on time scales of days, yet sufficient long-term accuracy to measure inter-annual variability and episodic events. For example, changes in dissolved O_2 or N_2 saturation levels associated with the passage of a storm can be less than a few percent. To resolve well such a change requires measurements with sensitivity of the order of 0.01% or better. Seasonal changes in dissolved O_2 or N_2 saturation levels, due to warming and cooling cycles, can be only 10% in the open ocean. Inter-annual variability is typically only a small fraction of the seasonal change. Achieving the required resolution and accuracy in dissolved gas measurement is a challenge! Problems associated with bio-fouling and/or corrosion are always present in seawater. We present an overview and up-to-date of the development and testing of various ultra-stable dissolved O_2, N_2 and dissolved air sensors, specifically designed to measure dissolved gas partial pressures directly using highly accurate pressure sensors (stability of 0.01 % per year and a resolution of better than 0.001%). In principle, at least, the sensors should be free from bio-fouling problems.

2. MOTIVATION

Identified below are four areas of research which provide motivation for the continued development of ultra-stable *in-situ* sensors to measure dissolved O_2/N_2 ratios:

- Changes in upper ocean N_2 saturation levels by purely biological processes are typically several orders of magnitude less than corresponding changes in O_2 or CO_2 saturation levels over time scales of days to weeks. Simultaneous measurements of two gases with disparate biological 'activity' provide a means of separating physical and chemical processes from biological processes. Inclusion of N_2 as a 'tracer' in coupled bio-geochemical models should provide a useful means to assess and ground-truth the model's accuracy in describing physical and chemical processes *versus* biological processes affecting dissolved gas distributions.
- Direct measurement of air-sea exchange rates of weakly soluble gases at low wind speeds.
- The study of bubble mediated air-sea gas transfer at high wind speeds. Note that the air-sea flux of O_2 depends on the saturation level of N_2, and *vice versa*.
- Direct measurement of N_2 fixation rates? This may be feasible, but presumably only under near 'ideal' oceanographic conditions, and when air-sea gas exchange can be neglected from the N_2 budget (*e.g.*, using measurements obtained during a Lagrangian study and in strongly stratified, non-mixed, waters).